COMPONENTS OF INFORMATION TECHNOLOGY

4.0 INTRODUCTION

Information Technology (IT) is a generic term that covers the acquisition, processing, storage and dissemination of information. It involves the application of computers and communication technology in the task of information handling, information and information flow from the generation to the utilization levels. It is restricted to systems dependent on microelectronics based combination of computers and telecommunication technologies. The IT is the boon for mankind. It gives accessibility to information at fingertips. There has been discussion on 'Information highways' and high tech libraries. The promising and diversified possibilities of IT have reduced the space and time between the people, countries, continents and ultimately have led to the emerging concepts 'Global Society' and 'Global Village.' Hence it is essential to give a bird's eye view of IT and its changing trends in relation to library and information applications.

4.1 HISTORICAL DEVELOPMENT OF INFORMATION TECHNOLOGY

Information Technology as a technical support for human thinking and communication has been evolving over thousand of years. New developments have been rapid over the last few decades. It is only recently that the term has been used as a collection term for the whole spectrum of technologies providing the ways and means to acquire, store, transmit, retrieve and process information. According to Manfred Kochen, any technology develops in three stages "In the first stage, technology enables us to do things, that we have been doing, but to do them better, cheaper and faster. In the second stage, technology provides new capabilities and enables us to do things that we had not been able to do previously. And in the third stage, technology becomes an integral part of our activities; it affects the way we do things and changes our life style. Development in computer and communication technology has brought a new dimension to the program of information handling. The introduction of microprocessor and microcomputers has made thing easier. All these developments facilitate better and quicker services to the user (1).

4.2 DEFINITIONS OF INFORMATION TECHNOLOGY

Information Technology (IT) is a new technology applied to the creation, storage, selection, transformation and distribution of information of many kinds. It has been defined differently by different people. IT, as defined by the ***Information Technology Association of America*** *(ITAA)*, is "the study, design, development, implementation, support or management of computer-based *information systems*, particularly software applications and computer hardware." It deals with the use of electronic ***computers*** and ***computer software*** to ***convert***, ***store***, ***protect***, ***process***, ***transmit*** and ***retrieve*** information, securely. The British Department of Industry considers IT as science of information handling, particularly by computers, used to support the communication of knowledge in technical, economical and social fields. It defines IT as, "The acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by microelectronics based combination of computing and telecommunication" (2). According to Mall, IT means, "Various means of obtaining, storage, and transforming information using computer, communication and micro-electronics" (3). UNESCO defines IT, "Scientific technology and engineering disciplines and the management techniques used in information handling and processing their application, computers and their interaction with men and machines and associated social, economic and cultural matters'' (4).

Zorkolzy has discussed IT from four different view points, such as 'society, economics, technology and the individual'. He says that common element of IT is the concept and volume information. Further he mentions the four features, which affect the quality of information, such as accuracy, content (The breadth/ Scope), regency and frequency of presentation (5). According to ILA glossary IT is "the application of the computers and other technologies to the acquisition, organization, storage, retrieval and dissemination of information' (6). According to Gopinath, IT consists, "a group of technologies, which particularly cover the computers capability to store and process information known as information processing and telecommunication technology which are capable of transmitting information to distances" (7). Thus information science and technology, deals with

the study of computers, telecommunication etc. for storing organizing and retrieving information of all kinds.

4.3 OBJECTIVES OF INFORMATION TECHNOLOGY

The objectives of IT are to provide better means of information of data messages in the form of written or printed records, electric, audio or video signals by using wires, cables and telecommunication techniques, IT plays a vital role in information handling due to developments such as reduction in computing time, capabilities of files on video discs, use of T.V as readymade information screen, telecommunication and satellite communication facilities etc. The objectives of IT in ICLs can be categorized into the following four groups.

(i) Supporting technical functions associated with acquisitions, technical processing, serial control, SDI/CAS, OPAC and circulation work.

(ii) Supporting information storage, retrieval and dissemination systems.

(iii) Supporting management information services for libraries, especially analyzing library statistics.

(iv) It can best be used in service and orientation courses for practicing librarians, continuing education programs for faculty teachers of library and information science, correspondence studies and library extension services (8).

4.4 COMPONENTS OF INFORMATION TECHNOLOGY

Technological change is becoming a driven force in our society. Like the internal combination engines at earlier era, IT is shaping and changing the capabilities of libraries, a description of these developments is essential. The IT can be broadly grouped under the major following areas:

4.4.1 COMPUTER TECHNOLOGY

The wide spread use of computer technology has made magic development in the information transmission processes, in every field of human endeavor during the past few years. It is likely to changes the information infrastructure by merging itself with other related technologies. Highly sophistication service from elaborate

abstracting and indexing services to computerized database in almost all scientific disciplines are in wide use all in the world. If two decades ago, computer was something that was within the reach of only a privileged few technologists and scientists but today the hard reality has gradually dawned on all of us, that must either live with computers or get lost. Computer is an automatic IS & R transferring electronic machine and a landmark in IT history, capable of performing a series of operations according to a set of logical instructions with utmost speed. Its storage capacity facilitates access to billions of characters of data in the storage and retrieval of vast and ever increasing information. Recent developments in computer and communication technologies have brought in new hope towards information management. Through central processing and storage, any information centre can access the world of information irrespective of geographical location via terminals. From vacuum tubes to transistors and then onto integrated circuits and silicon chips, computers have improved their refinement and efficiency with each successive generation. Though much cheaper now, these computers use better in memory capacity, computational speed and I/O time. Interactive working in time-sharing and multiprogramming is also possible now. The developments have resulted in the era of low cost computers having smaller dimension and with low power requirements. This is of great importance to scientific and technical communication. In house, microcomputers are the keystone of new technologies used for more sophisticated data and text processing, database manage and a variety of other applications. It provides extremely rapid access to the information that is necessary to support decision making in the clinical as well as in the research and teaching environments of college, institutions, hospitals, etc. Computers are used for precision, accuracy, speed and manipulation of large amount of data involving complete operation. With the advent of microprocessor technology, it was possible by integrated circuit device to put a very large scale data into a quarter of a square inch. Computers have been grouped into fourcategories such as: microcomputers, microprocessors, minicomputers, mainframe computers and supercomputers.

Today, everyone is compelled to understand capabilities, limitations and potential application of computers in their respective areas of specialization to cope

up with the increasing demands of modern society. The use of computers for IS & R began with the production of computer generated and printed indices for scientific and technical literature in late 1960's. Subsequently, several organizations have started using computers not only for generation and printing indices but also for creation of factual and textual databases containing all length documents. The initial small silicon chips contained only a few components and circuits, but the average number of chips components has doubled each year since 1965. Early Small Scale Integration (SSI) efforts, first gave way to Large Scale Integration (LSI) chips that contained thousands of components. Now Very Large Scale Integration (VLSI) chips contain hundreds of thousands elements and Ultra Large-Scale Integration (ULSI) chips with millions of components are also going to be available in near future. By early 1970s, several indexing and abstracting journals were published for library applications, viz., Index Medicus, Chemical Abstract, Biological Abstract, etc. These were not only produced by computer but were also made available as computer readable databases on magnetic tapes and/or CD-ROM. Several organizations had started subscribing them on magnetic media to organize local IS & R services. By the mid 1970's, several organizations including National Library of Medicine (NLM) (USA) and System Development Corporation (SDC) had started offering online searches, from remote terminals from a variety of machine readable indexing and abstracting databases. The microcomputer, a complete computer on a single silicon chip, is behind many of the recent changes in information handling technologies. Microcomputers (PCs) can perform many of the information handling functions traditionally run on larger computers, such as, acquisition, circulation control, catalogue card production, Current Awareness Service/ Selective Dissemination of Information (CAS/SDI), Information Storage and Retrieval (IS & R), etc. In addition, the introduction of microcomputers for information handling has resulted in the development of a number of innovative applications viz. "Reference Librarians" Enhancement System (REFLES), retrospective catalogue conversion on MINIMARC, etc (9).

4.4.1.1 Computer: A Brief History

The computer is neither a product of a single stroke of genius; nor is created overnight, as it may have seemed to some people. The computer actually evolved

from devices used in earlier centuries, and in our own century many different people over many years contributed to its remarkable development. Computer field, itself is developing very fast. Hardware (HD) has replaced old punch-card, tapes, drums and CDs. Computer Technology has undergone tremendous changes in both Hardware (HW) and Software (SW) capabilities. To examine computer equipment and facilities its past and present, one must look at the applications that have influenced their progress. It would be accurate to give a bird's eye view to its various developments.

a) Hardware: During the 16^{th} and 17^{th} centuries, commerce in Europe was flourishing to such an extent that manual machine were considered as inadequate. In their quest for greater speed and dependability, inventors began to come out with more complex mechanical machines (**Table 4.1**) (10).

Table 4.1 Evolution of Computer

Year	Inventor	Name of the machine
Early 1600s	John Napier (Scotland)	Napier's Bones (Calculating device)
1642	Blaise Pascal (French)	Mechanical Calculator
1671	Gottfried Wilhelm von Leibniz	Calculator for all the calculation
1786	J. H. Miller(German)	Difference Engine
1822-32	Ada Augusta Lo Velace	Analytical Engine Base(Computer Programme)
1942	John Vincent and Clifford Berry	ABC
1944	AikeriMH(Harvard)	MARK-1
1947	JPEch	UNIMAR-I

b) Modern Computers: Till 1930, there were no significant developments. During this time Howard H. Aiken, Harvard University, a mathematics professor, was probing into the possibilities of electrically operated high speed mechanical calculating devices. In 1944, he produced the first electromechanical computer called MARK-I. International Business Machine Corporation (popularly known as IBM, who was engaged in producing business, financed it. Aiken actually incorporated many features in his electromechanical computer that Babbage had conceived hundred years earlier. It was 51 feet long, high, huge machine and relied on vacuum tubes Dr. John Vincent Atanasoff of Iowa State College together with

his assistant Clifford Berry constructed a working model of ABC (Atanasoff-Berry-Computer) in 1942 now as a digital computer as it used the On/Off state of electricity to represent numerical digits. MARK-I and ABC influenced the development of the next major computer system ENIAC (Electronic Numerical Integrator and Computer). It was completed in 1946 and was the fastest calculator to-date Dr. John von Neumann, who served as a consultant to ENIAC system came with the concept of computer memory and the stored programme. In 1952, at the University of Pennsylvania, Neumann's concept was implemented in the digital computer, Electronic Discrete Variable Automatic Computer (EDVAC). In 1947, J.P. Eck built UNIMARC-I (Universal Automatic Computer). In 1951, UNIVAC become the first commercially available stored-programme computer and the computer race was on (11).

C) Computer Generations

The computers have been grouped into chronological categories, called generations (Table 4.2). Computer generation means a step of advancement in technology. It also reflects the growth of computer industry. The advancement in technology existed not only in hardware but also in software. The evolution of modern computer is divided in different generations as below.

1. First Generation: The first generation of computers was developed in late 1940s. In this generation of computers, vacuum tubes were used and these were bulky in size.

2. Second Generation: In the generation of computers, solid state devices called transistors, diodes etc. were developed by William Shockley and colleagues at Bell laboratories. These solid state devices were used in place of vacuum tubes. This replacement increased the speed of computers and other drawbacks were reduced. Second generation computers were smaller in size, cheaper in manufacturing. These computers occupied lesser space and consumed lesser power.

3. Third Generation: These computers have secondary storage devices and new input and output devices like visual display terminals, magnetic ink readers and high speed printers, integrated solid state circuit (IC chips). I.C. chips increased the speed of these computers. These computers performed the arithmetic and logic operations in micro- seconds (Millionths of a second) or even in nano-second

(Billionths of a second). The size and cost of these computers have decreased considerably.

4. Fourth Generation: Integrated Circuits Technology was further developed. In 1971, INTEL Corp. of USA developed the IC chips which have the entire computer circuit on a single silicon chip. These chips are called microprocessors. These microprocessors gave birth to micro-computers called micro-processors. In 1976, Steve Wozniak developed a series of micro-computers called 'The Allple Series.' These computers were the most modern computers. These were much cheaper relative to performance in comparison to early computers.

5. Fifth Generation: Fifth generation computers are those computers, which not only have the advanced capabilities like speed, accuracy, storage and retrieval capabilities of other computers but have also additional ability to think and make decisions. The ability of intelligence in computers is called Artificial Intelligence (AI). Japanese have named this generation of computers as KIPS (Knowledge Information on Processing System) (12).

Table- 4.2: Computer Generations

Generation	Year	Use	Example
1st Generation	1945-1956	Vacuum Tube	ABC, Z3, Colossus, ENIAC, EDVAC, UNIVAC and IBM
2nd Generation	1956-1963	Transistor Technology	IBM 1401, IBM1620 , LARC, MCR300, Programming RCA301 and Honey-well-400
3rd Generation	1964-1971	IC (Integrated Circuit) Technology	Sperry, Burroughs, DEC,NCR and Honey-well IBM
4th Generation	1971-present	LSI (Large Scale Integration) VLSI (Chips + Semiconductor)	Microprocessor till to date
5th Generation	Present & beyond	Recent advances	Pentium (s) Latest: pentium4

4.4.2 COMMUNICATION TECHNOLOGY (CT)

The recent IT revolution has transformed the communication-conscious human society into, an information global village in a short span of just two

decades. The new technologies like the laser, fiber optics, telephone, teleprinter, telex, television dictaphone, silicon chip, Internet and many other telecommunication devices have come to constitute an important and inevitable component of written and oral communication media network. These modern communication technologies have the potential to bypass several stages and sequences in the process of development encountered in the earlier decades. The advents of communication technology have revolutionized the activities of library and information system. The concept of virtual or digital library has emerged and is synonymous to future library which largely works with ever-shifting arrays of allies, instead of acquiring large number of document employing staff to process them (13).

The word communication is derived form the Latin word *"communis"*, which means commons. In its application it means a common ground of understanding. It is a process of exchange of facts, ideas, opinions, feelings and as a means that individuals or organizations share meaning and understanding with another. Communication is interdisciplinary such as mathematics, electronics, linguistics, systems analysis, etymology, cybernetics, etc. Communication is the vital aspect to change behavior of the receiver. As matter of fact no executive can be successful. Message is in the form of words, symbols, signs, letters or actions. Communication is a tool of management to get the things done through people. Generally the process of communication demands the necessity of a transmitter, message, symbols, channel, decoding, receiver, action and feedback. It is a continuous process or cycle of sending message and feedback. The basic methods and guiding objectives of development and technical co-operation are richly embodied in the term *communication*. Who's many means includes *Sharing* and *Equity* (14). Communication Technology is a vital aspect of human activity and LISc faculty members and students are no exception to it.

4.4.2.1 Definitions of Communication

Charles Cooley defines communication technology as *"the mechanism through which all human relations exists and developed-all the symbols of the mind together with the means of conveying through space and preserving them in*

time" (15). George Lundberg considers communication as, *"a sub category of interaction, namely the form of interaction using symbols, gesture, picture, verbal or any other which would serve as stimuli to behavior"* (16). According to Newman and Summer, *"communication is an exchange of facts, ideas, opinions or emotions by two or more persons* (17). Theo Haiman has discussed communications as *"the process of passing information and understanding from one person to another."* It is the process of imparting ideas and making one self-understood by other (18). Chester Barnard said that in any exhaustive theory of organization, communication would occupy a central place because the structure, extensiveness and scope of organizations are almost entirely determined by communication techniques' (19). According to Charles Berger and Steven Chaffe, *"communication science is the branch of science seeks to understand the production, processing and effects of symbol and signal systems by developing testable theories, containing lawful generalization, that explain phenomenon associated with production, processing and effects"* (20).

4.4.2.2 Nature and Scope of Communication

The nature of communication is exchange of messages and interaction. It transmits information and data to the sub system as well as to the total system of a society. There must be two parties in the process of communication. The communicator or sender or transmitter of the message and the receiver or recipient or listener or reader is in another party. The scope of communication is very wide and comprehensive. It is a subject of almost unlimited dimensions and is interdisciplinary one. Communication is two-way process involving both transmission as well as reception. It is a continuous process of exchange of facts, ideas, feeling, attitudes, opinions, figures and interactions with others. In the process its uses a set of symbols like words, action, pictures, figures, etc (21).

4.4.2.3 Communication Media

Media in relation to communication imply tools of communication. It means the instrument or instruments adopted or applied in transmitting any message irrespective of its nature and significance. Media are concerned with the

form into which the message is placed of various communication media. There are four communication media, which have close relationship with library as communication agency, they are: oral communication, audio-visual communication, verbal or written or printed communication and mass media communication.

4.4.2.4 Process of Communications

Communication is a process of exchange of ideas, facts opinions and manner by which the receiver of the massage shares meaning and understanding with another. It is organizational process, because a group of people and group activities are involved without this process, organizational activities do not progress. According to David K. Berlo, the whole process of communication involves six different steps as:

Ideation → Encoding → Transmission → Receiving → Decoding → Acting (22).

The entire process of communication consists of eight important elements as follows:

i) Message: A piece of information, spoken on written to be passed from one person to another. It is the subject matter of communication. It may involve any fact, idea, opinion, figure, attitude or course of action including information. It exists in the mind of the communicator.

ii) Transmitter: Transmitter is sender of message or communicate or speaker, a person who transmit the message. In the case of mechanical device used for communication, Para transmitter is an operator that transmit message. The person who conveys the message is known as the communicator or sender.

iii) Encoding: The process of conversion of the subject matter into symbols is called encoding. The message or subject matter of any communication is always abstract and intangible transmission of the message requires the use of certain symbols. Encoding process translates ideas, word, facts, feelings, opinions into symbols, signs actions, pictures and audio-visuals, etc.

iv) Communication Channel: Communication channel means the medium or through message passes. The words, symbols, or signs selected should be transmitted to the receiver through certain channel or medium. The media may be

written media or oral media. Further there are various forms of written media like letters, reports, manual, circulars, notes, questionnaires etc. The forms of oral media includes face-to face conversation, dictaphone, telephone, teleconferencing, television, documentary films, CD-ROMs, etc. represent audio-visual channels.

v) Receiver: Receiver is the person to whom the message is meant for by the sender. A person, who receives the message is called receiver. Responding or acting to the message done by the receiver only.

vii) Decoding: Decoding is the process of translation of an encoder message into ordinary understandable language. Receiver converts the symbols, word or sign received from the sender to get the meaning of the message.

viii) Acting: According to the understanding of the message, the receive acts or implements the message.

ix) Feedback: Feedback is though the last element an important one in the communication process. The sending back of the knowledge about the message to the transmitter is known as feedback. It ensures that the received the message and understood in the same sense as the sender meant (23).

4.4.2.5 Communication Theories

There are many communication process models and theories to understand the process involved in it as developed by different scientists. Some of these important theories are as follows.

(a) Mathematical Theory

The mathematical theory of communication development by the C. E. Shannon and Weaver, popularly called Shannon-Weaver model, was developed in 1949 as a model in the electronics communication they considered the theory as strictly mathematical and as been identified with technology and technical aspects of communication. It created in impact on such concept as measuring the units of the information transmitted over technical channel (24). Shannon concerned with the technical problems of the transmitting signals from one point to another. He considered communication as a mechanistic system consisting of the following five basic elements such as,

(i) Information → source

(ii) Transmitter → to convert a message into transmittable signals

(iii) Channel → medium or agency

(iv) Receiver → who reconstructs the message from the signals

(v) Destination → the person or machine to which it is intended

Some of the components he introduced in the systems are the message, transmitted signals, received signals and noise source. Shannon and Weaver model contains the essential elements for explaining the human communication processes (25).

(b) Information Theory

In 1959, the information theory developed separately from the communication theory. The components of the information theory are the computer science, data processing cyber nets etc. Each of these areas has been contributing to communication theory. Thus information theory gives a multi disciplinary approach to the communication theory. In recent year the communication theory has been considered as an interdisciplinary theory. As such it is still in an interrogative stage of development, for it has been drawn from various disciplines. After recognizing communication as an interdisciplinary, there is a need to draw from various discipliners of different view points like Psychology, Mathematics, Linguistics, Etymology, Semantics, management, English, Sociology, etc (26).

4.4.2.6 Advantages of Communication Technology

The impact of communication technology in information science has been increasing in importance, as interactive information retrieval systems have been developed, that allow users dispersed over wide region to obtain access to these systems on a real time basis. Computer based information retrieval system form one broad class of system that can be linked to users in their office, homes as well as to users in libraries and other centers.

i) Time Saving: Modern communication technologies avoid errors, duplication resulting in saving of time. They have more speed with accuracy and can transmit

quickly. The message lead which the machine can do is definitely more and resulting in saving of time of superiors and subordinates in the organization.

ii) Saving Labour Cost: New communication technologies are labour saving devices. They save labour as well as payroll cost. Less number of workers or staff are sufficient with the installation of modern communication devices. The staff thereby released can be utilized for alternative works.

iii) Speed: A large quantity of information can be fed into the machine, which in term transmits with considerable speed. In respect of certain matters, speed and quickness are necessary to take quick decision. The handling of transmission is assigned to electrically or electronically or radio-wave operated machine which are known for greater speed of dispatch. Frap Palo, gives an example "where with advanced fiber optics, it is possible to transmit the entire contents of the library of congress (60 terra bytes of information of 60 billion sheets of paper) from Chicago to New York in only two hours. Over the traditional copper wirings the same transmission would take 2000 years to complete" (27).

iv) Reduce Monotony: Routine respective work may lead to fatigue or monotony mechanization of communication system reduces the fatigue of the staff and resulting in improving the efficiency and quality of the work. For instance use of visual and audio-visual aids will reduce fatigue, which improves the quality of work.

v) Equality: New technology can achieve equality in the provisions of communication reaching particularly with reference to geographical location.

vi) Standardization: Standardization of work can be achieved through machines. The ensure consistency uniformity in the quality as well as quantity of work the principle of standardization is so important that no one can afford to ignore its advantages.

vii) Accuracy and Efficiency: Correctness of message transmission is necessary to enable a receiver to understand in same spirit and to act accordingly. The systematic and automatic technology promotes accuracy. The new technology in general increases efficiency (28).

4.4.3 TELECOMMUNICATION TECHNOLOGY

Telecommunications are devices and techniques used for transmission of information over long distances via wire, radio/satellite without damaging/loss due to noise and interference. Telecommunication was born in 1844, when the message, 'WHAT HATH GOD WROUGHT' was transmitted across a 40 miles span by telegraph. Thirty-two years after Samuel FB Morse's legendary feat, Alexander Graham Bell uttered a call for help on his invention that thrusts telecommunication industry into the era of Voice Communications. The major trend in elecommunications at present is a fundamental shift from mechanical to electrical furthermore, electronic , and within electronic, analogue to digital modes of transmission involving all types of communications voice, facsimile, computer transmission, TV communicators, microwave and satellite communications, and radio links. On the other hand, certain applications of microcomputers (PCs) have opened new vistas for the transfer of information by telecommunications. The development of microelectronics has led to home minicomputers and TV based information terminals. Recently, there have been considerable activities in evaluating the potential for DDS on satellite communications. Applications in the information field include remote browsing, using TV, searching of automated catalogues (OPAC), searching of bibliographic and numeric data, SDI/CAS services, DDS via various telecommunication devices. Electronic communication consists of telecommunication and data communications. Telecommunication involves use of telephone, tele-printer, telegraph, radio or TV and satellite facilities to transmit information, either directly or via computer. Data communication is the transfer of data/information between computer devices, and is a common that each of us has probably seen it in action everyday life without thinking about it. The other major current developments in CT are: E mail, electronic imaging, electronic publishing and DTP, tele-text, teleconferencing, video-text technology, fax, voice mail, satellite, telemedicine, etc (29).

Advent of Computer Technology (CT), IT and communication technology has revolutionized the activities of library and information system. The 'hi-tech' enables the user to access the required information in no time. Especially the advent of telecommunication technology and the tremendous speed, with which it

is changing, require adaptability to change in present information society. Hence, it should be essential element in professional preparation of future library and information science personnel. The concept of 'digital library' has emerged as synonymous to future library which largely works with an ever shifting arrays of parts and allies instead of acquiring large number of documents and employing people to process them.

4.4.3.1 Origin of Telecommunication

Telecommunication is an area of Information Technology, which is currently undergoing radical change. The word 'Tele' means 'at a distance' and the word 'communication' means exchange of ideas. Consequently, Telecommunication may be defined as the transmission of representations of information between remote locations by electronic means (30). A wide variety of information is transformed is by such systems including sound, visual images, computer processed data, telegraph and teletypewriter signals.

4.4.3.2 Historical Developments of Telecommunication

The earliest form of communication was visual signaling with smoke, flags or lamps, etc. However, in the eighteenth century a revolution in communications begin with the development some crude techniques. In 1947, William Watson demonstrated that electricity could be transmitted over a two-mile wire using an electrostatic source. Nearly one hundred years later Wheatstone in England and Morse and Vial in USA implemented the first practical telegraph systems. Morse's system becomes widely used. Underwater cables could be constructed after the discovery of "Gupta-percha" and a permanent cable was laid between the USA and Great Britain in 1886.

Modern telecommunications began in 1876, with the invention of the telephone by Alexander Graham Bell crude electromagnetic devices converted voice to and from electrical signals that could be sent over copper wires from place to place. Initially human operators enabled manual selection of destinations, switching functions that become the heart of telephone network. Electromagnetic relay switches of increasing sophistication were developed, but since 1947, when

Bell Telephone Laboratories invented the transistor, which in tern spawned the integrated circuits, switches have become electronic with steadily increasing speed.

By the second half of the twentieth century the development of cables with substantially increased capacities and the application of fiber optics as well the microwave transmission of television signals in connection with satellite technology, meant to a wide variety of signals could be sent around the world instantaneously. In the above mentioned technologies, analog representations of information have been rapidly giving way to digital, offering higher quality and performance. A revolution is also occurring in the customer premises equipment from the simple telephone to multi-function terminals, personal computers and workstations.

4.4.3.3 Telecommunication Tools

The important telecommunication tools are as follows:

1. **Telegram**: A written message supplied to the department of telecommunication, which in turns sends, the message by telegram.
2. **Telegraph**: A system of sending message by telegraph using both wires and electricity or radio.
3. **Telegraphy**: With reference to telecommunication, telegraphy is the process of sending message by telegraph. Telegraph wire by which telegraph messages are sent.
4. **Telepathy**: A quite different style of communication of ideas, though directly from one's mind without the use of audio or visual.
5. **Telephone Directory**: Directory is a specially prepared type of book containing the names and address of a particular group. Telephone directory is a list of names, addresses and telephone numbers of a group of all the people in a particular area who have telephones and the arrangement is according to alphabetical order.
6. **Telephone exchange**: A centrally-controlled system through which telephone calls are directed. The use of telephone exchange is necessary in case of non-STD and in the absence of direct dialing operation.

7. **Teleprinter**: Teleprinter is a specialized type of typewriter used in communication system.
8. **Teletype**: Teleprinter is a specialized type of typewriter used in communication system.
9. **Telex**: Sending of messages through teleprinter is called telex.
10. **Telecom**: Telecom signifies inter-communication system used to communicate with one another, especially to talk between two rooms, officer, etc. by means of a telephone or a radio system.

4.4.3.3.1 Telegraph

The world telegraph comes from Greek words 'Tele' which means a far and 'graphein' meaning write. The method of communication employing electrical signaling impulses produced and received manually or by machines. Telegraphy as communication techniques uses essentially a narrow frequency band and a transmission rate adapted to machine operations. 'TEL uh graf' was the first method used to send messages by electricity. Tapping outwards letter by letter with a telegraph sent at one time most telegraph message. Early equipment devised by Samuel F. B. Morse consisted of a mechanical transmitter and receiver. Operators soon learned to handle messages faster by using simple manual keys, and audible sounders. The telegraph revolutionized long distance communication. Until its invention, messengers served as the chief means of communication at a distance. In 1790's Claude Chappe, a French inventor established a system visual telegraph is semaphores that relayed messages across France. In 1820, Hans Christian Oersted of Denmark showed that an electric current could produce a magnetic field that an electric current can produce a magnetic field that will turn a compass needle. Using the electromagnetic techniques three scientists namely William F. Cooks, Charles Wheatstone and F. B. Morse developed successful electrical telegraphs. Today, machines telegraph, messages. The facsimile machine has a keyboard, and the operator's sends a message by typing it. A printing device a receiving it automatically types it on the paper (31).

4.4.3.3.2 Telephone

The telephone has gradually supplemented the telegraph as the principle system of telecommunications. Not only does the telephone service as an instrument for reproducing articulate speech and other sounds at a distance through the medium of electric waves but its circuits carry telegraph telephoto and television signals and data in a form that can be fed directly into processing devices. In effect telephone circuits enable computers at remote points to communicate with each other. As a consequence telephone systems have become an integral part of modern telecommunication system, intern telecommunication systems have become an integral part of IT.

4.4.3.3.2.1 Operating Principles

In telephone, the voice vibrates the air, which in turn vibrates a diaphragm. The motion of the diaphragm produces a corresponding vibration in an electric current. The basic components of a typical long distance telecommunications system capable of transmitting voice, teletypewriter, facsimile, data or television signals. If digital transmission is employed, signals are first processed in a coder that completely transforms their character. Typically the coder includes filtering and coding circuits that convert the signals into digital form; in data transmission that step is bypassed because the signals are already in digital form. A telecommunication network, at its simplest, may be regarded as compressing a transmission network, an arrangement of transmission paths and switching centers through which signals are conveyed by a physical transmission medium. Information coming from a source, or to a receiver, is converted via a terminal into signals appropriate to the characteristics of the particular network.

Although there are specialized networks for digital data, if conventional voice telecommunication lines are used for part of the transmission, the signals must be converted by the transmitting system into analogue form. The analogue signals are converted back into digital form at the receiving end. Modulator and demodulator (Modem) carry out this process. The transmission media used in telecommunication networks vary both physically and in their carrying capacity. The most usually quoted performance measurement of a telecommunications link

is its 'bandwidth'. This gives an indication of the range of frequencies, which can be transmitted by the channel and is expressed in frequency units like hertz, kilohertz, megahertz, etc. The greater the bandwidth is, the greater the rate at which data can be transmitted.

4.4.3.4 Important Types of Media Used on Telecommunication Networks

i) Twisted Pairs of cable: Twisted pairs cables are used to transmit signals and are commonly used in telecommunication (for conventional voice Telephone and Telex). They are two colour-coded, insulated copper wires that are twisted around each other. A twisted pair cable consists of one or more twisted pairs in a common jacket.

ii) Coaxial Cables: coaxial cable is the most common type on networking cable. It consists of an inner wire surrounded by a layer of insulating material, a conducting layer of woven wire, another layer of insulation and a plastic covering. It is used also for data networks and in local area networks due to its wider bandwidth, interface resistance, high conductivity and longer distance coverage.

iii) Optical Fibers: This type of cable consists of thin glass or plastic filament, protected by thick plastic padding and an external plastic sheath. Optical fibers gradually replaced twisted pairs in the voice network as well as being installed in data network. These fibers carry signals in the form of laser light instead of an electronic frequency, and hence can carry large volumes of data at high speed and are resistant to interface.

iv) Radio/Mobile Communication: Radio/mobile communication is the rapidly growing area of telecommunication. Cordless phone, cellular phones, new personal communication network (PCN) systems, etc. are the examples of this category.

v) Satellite: Satellites are used extensively for general telecommunications, as well as for television. Originally contemplated only for long distance, trans world links but increasingly employed for high speed, high volume transfers.

4.4.3.5 Telecommunication Standards and Protocols

Standards are crucial in the telecommunications field if data is to be transmitted successfully between different manufacturers equipment. The

International Telecommunication Union (ITU) and its attached organization Consultative Committee for International Telephone and Telegraph (CCITT) have been concerned with standardization of Telecommunication equipment and facilities for data communications. Broadly speaking the approach of ITU (International Telecommunication Union) is to consider the problems of both advanced and developing countries. According to CCITT, standardization avoids many problems in the process of data communications, such as:

1. The use of the existing telegraph and telex, network for data communications.
2. The use of the Public switched telephone network.
3. The use of the separate network dedicated to `data services' (public data network)
4. The use of an integrated service digital network.

4.4.3.6 Telecom Services to Subscribers

The Telecom policy envisages many value-added services to subscribers such as:

i) Paging Service: Paging has emerged as an integral part of business and personal communication world wide due to its speed, mobility and low cost. A pager is a handheld, any-way wireless communication device that receives numeric or alphanumeric messages. Three categories of people are essential in paging services, the sender who sends the message, the paging operator who beams the message, the paging operator, who beams the message and the receiver who is the target of it. There is also auto-paging facility, which bypasses the operator. Each pager will have identification number (Subscriber number). In order to send the message, the sender has to dial a four-digit number (Paging Access Number) in his or her telephone and tell the identification number and message to the service operator. The message is entered into a computer and immediately transmitted throughout the operating area. The receiver's pager vibrates or beeps and displays the message. The messages can be also be stored in the memory of the pager depending on its storage capacity. All this takes one minute or so. There is no direct application of pagers in libraries or Information centers. However, in rare

cases this can be used to provide information to be delivered through telephone (32).

ii) Cellular Mobile Phones: Cellular Service is a Terrestrial Radio based service providing two way communications by dividing the servicing area into a regular pattern of Sub-Areas or Cells. Each cell will have a base station with a low power transmitter or receiver. The base station receives, transmits, and routes the call to from the users in its service area. All base stations are connected to a unit called the Mobile Services Switching Centre (MSSC).

The MSSC carries our several complex functions like locating the mobile user, establishing connection and traffic management. It also shifts the calls as users move, say in a car, from one cell to another, while the call is going on. MSSC serves as an interface between the cellular network and Public Telephone System so that cellular service users can make or receive Local, STD and international calls (ISD). Telephone linked with the computer is emerging as the hub of all information transmission activities and therefore cellular phones are a boon to those who want information instantaneously from ICLs, irrespective of the place at which they are stationed.

iii) Data Services: The rapid developments in telecommunication technology have made it possible to access data stored anywhere in the world. It is very well acknowledged that for speedy growth of industry and commerce (33). Many libraries and information centers utilize data networks to access online databases (34).

iv) Videoconferencing: Videoconferencing is a method of holding conferences by transmitting and data communication networks, so that participants can both see and hear each other. It allows people in different locations to meet face to face, while being physically thousands of Kilometers apart. It is a new way to hold meetings (35).

v) Teleconferencing: Teleconferencing is a generic term that denotes the combined use of telecommunications and electronic technologies as an alternative to in-person meetings. In fact it is a sort of network capability that uses the telephone as a medium for voice transmission, television for video, and computer

for data transmission service. Data terminal are connected together via the telephone network.

vi) Videotext: Videotext systems deliver information to specially modified television receivers. In videotext technology a number of innovative approaches involving various combinations of transmission technologies like telephone cables, TV cable, satellite, and optical fibers have been recommended for videotext delivery. Video text systems have been divided into two categories: teletext and viewdata, which are differentiated by the information dissemination methodology they employ. Teletext system, sometimes called "broadcast videotext", is an information service. Information is sent or transmitted, at the same time as a television signal. A television set with a decoder and a special keypad is needed to use teletext (36). Viewdata: systems transmit information stored in computer databases through a telephone line and display them on a television screen or computer terminals. The simplest terminal is a television receiver equipped with a viewdata decoder, typewriter-like keyboard, and modem. Viewdata systems resemble conventional timesharing computer services, although the information they offer is a distinctively packaged combination of text and graphics.

4.4.3.7 Modern Trends

4.4.3.7.1 Very Small Aperture Terminal (VSAT)

VSAT's networks facilities either one way applications like information dissemination, training and advertising or two way communications like facsimile and document transfer, digital voice, compressed video, reservation system, file transfer, etc. There is a tremendous potential for VSAT in networking library services (37). The project entitled TITAN (Telemetry Instrumentation and Telecommunication in an Automated Network) utilities as integrated communication, telemetry; computer based remote monitoring and electric control system. It is setting up communication and tele-supervisory control system. The equipment, direct to line multiplex equipment, electron telephone exchanges, computer based tele-supervisory control system large antennae for satellite earth stations and electrons for the earth stations (38).

4.4.3.7.2 The ISDN

The term ISDN (Integrated Services Digital Network) is given to all digital networks that can simultaneously carry voice and data communication, and offer additionally a variety of teletex services. ISDN provides integrated voice and data on common telephone company facilities. It is a type of network, which is going to integrate a large number of existing services separately like telephone, telex, data, image, videotext, etc. It has come about due to greater demands by users of the existing services as regards the performance and flexibility, which led to an increase in the types of services each bringing a new network with it (39).

4.4.3.7.3 The concept of ISDN

According to CCITT, ISDN is an end to end digital network that supports a wide range of services accessible by a limited set of standard multiplication user network interfaces. This approach allows users to connect their telephones, data and text and low speed video terminals to the same link and removes the need of separate accessing links for each type of service, as it is the practice today. Another important characteristic of ISDN is the separation of information from signaling and management functions. Thus one could implement ISDN as a single all encompassing digital network with one integrated transport and switching fabric (40).

4.4.4 OPTICAL COMMUNICATION SYSTEMS

Optical communications are a recent addition to the armoury of telecommunication systems. Their main uses are in long distance digital networks. Here light is the carrier of information and optical fibers are the medium of transmitting the light signals. Optical fiber transmission has come of age as a major innovation in the telecommunications. Such systems offer extremely high bandwidth, freedom from external interference, immunity from interception by external means, and cheap raw materials like silicon (41).

Optical fibers are made of glass, which in turn, is made from sand, an inexpensive raw material available in unlimited amount. Fiber optic cables are similar to coaxial cables, except without the braid. At the center is the glass core true, which the light propagates. In multimode fibers, the core is fifty Microns in

diameter, about the thickness human hair. In single-mode fibers are more expensive but can be used for longer distances currently available single mode fibers and transmit data at served Gbps for 30km. Even higher data rates have been achieved in the laboratory for shorter distance. Experiments have shown that powerful lasers can drive a fiber 100-km long without repeaters, although at lower speeds. The core of the fiber cables are surrounded by a glass 'cladding' with a lower index of refraction than the core, to keep all the light in the core. Next comes a thin plastic jacket to protect the cladding. Fibers are typically grouped together in bundles, protected by an outer sheath.

4.4.4.1 Different types of Optical Communication system

Optical communication system can be categorized on the basic of transmission medium, wavelength and signal used to transmit the information (42).

i) Free Space Optical Communications: is a free-space optical channel exists, between orbiting satellites. A free space channel between satellites is in some sense, ideal it doesn't distort or attenuate the light beam. For this application, the laser is the best source because, it's spatially coherent radiation can be confined to a much smaller angle of divergence than can the inherent radiation from other sources.

ii) Atmospheric of Optical Communications: an atmospheric optical channel exists between satellite to earth communication and Terrestrial communications. The Earth's atmosphere strongly influences the transmission. Transmission losses are low in clear weather. However, minute temperature gradients along the path of the light beam cause beam to broaden and bend so that even in clear air the degradation can be served over longer paths.

iii) Optical Fiber Communication: optical fiber cables are the important medium of information flow, used in telecommunication system optical fiber has a very large information capacity in germs of bandwidth. The frequencies encompassing light wave transmission are very high in the electromagnetic spectrum. The reader recalls that bandwidth is largely dependent on the frequency range. Optical bandwidths in the range of 500 MHz. are common today.

4.4.4.2 Replacing Copper Telephone Lines with Fiber Optical Networks

As communication technology grows and changes the boundary lines that separated media in the past become increasingly difficult to sustain, and the need for new policies becomes more apparent. At the same time a communication system that is easier and simpler for users to operate requires a more complex and costly technology. This problem has recently been brought into sharp focus by the huge investment required to replace existing copper telephone, lines with a fiber-optic network capable of handling, on a broad frequency, a vast array of information and entertainment services. Since these would encompass both mass and private communications, a new set of policy issues has been raised regarding the relationship between public utilities highly regulated at the local level and mass media promoted by constitutional guarantees. The impending spread of fiber optic networks with broadband communication capabilities was destined to lower the artificial barrier between the data processing and communication. It also made obsolete the distinction that regulators had drawn among the various types of communication companies, in or out of the mass media field.

4.4.5 SATELLITE COMMUNICATION TECHNOLOGY

Satellite communication is one of most popularly extensively used technology now a day. The details are:

4.4.5.1 Historical Development

In the 1930s and early 1940s, scientists tried to set up communication system by bouncing signals off metallised weather balloons. Unfortunately, the received signals were too weak to be of any practical use. In 1946, J. H. Trexler of Noval Research Laboratory, USA used Moon, the natural satellite of earth, to bounce off UHF signals as part of his project (43).

Subsequently, it were these moon bounce studies which enabled Browne and some other scientists to discover, the “Transionospheric Faraday Rotation Effect’’, which is being successfully used now with transmission from artificial earth satellites for a variety of studies related to the total electron content of the ionosphere. Several series of orbiting satellites by NASA and Soviet Union were tried for communication and surveillance with different degrees of success until the

concept of 'Geostationary orbit' materialized and gave a quantum jump to satellite communication.

Further progress in the celestial communication satellite was launched in 1962. The key difference between an artificial satellite and real one is that the artificial one can amplify the signals before sending them back, turning a strange curiosity into a powerful communication system.

4.4.5.2 Communication Satellites

Communication Satellites have some interesting properties that make them attractive for many applications. A communication satellite can be thought of as a big microwave repeater in the sky. It contains several transponders, each of which listens to some portion of the spectrum, amplifies the incoming signal and then rebroadcasts it at another frequency, to avoid interference with the incoming signals. The down word beams can be board, covering a substantial fraction of the earth's or narrow board, covering a substantial fraction of the earth's or narrow covering an area only hundreds of kilometers in diameter. A typical satellite has 12-20 transponders, each with a 36-50 MHz bandwidth. A 50 Mbps transponder can be used to encode a signal 50 Mbps data stream, 800 64 kbps digital voice channels or various other combinations (44).

Further, two transponders can use different polarization's of the signal, so they can use the same frequency range without interfering. In the earliest satellites, the division of the transponders into channels was static, by splitting the bandwidth up into fixed frequency bands (FDM). Nowadays, time division multiplexing is also used due to its greater flexibility. Many of the current satellites are in a geosynchronous orbit. They rotate around the earth at 6,900 miles/hour and remain positioned over the same point at 22,300 miles above the equator. Thus the earth station's antenna can remain in one position is fixed. Further a Geosynchronous satellite with no-directional antennas can cover about 30% of the earth's surface. Thus Geosynchronous satellites can achieve worldwide coverage with three satellites spaced at 120º (120º + 120º + 120º = 360º) intervals from one another (45).

4.4.5.3 Future of Satellite Communication

Satellite communication certainly represents one of the more powerful technologies in information communication today. The advances made in the use of higher frequencies will result in smaller and cheaper earth station antennas. The potential applications for satellite use will increase dramatically as smaller antennas are made available.

The impact on the telephone companies, their local loops and on distributed processing are enormous with thousands of satellites in orbit, the earth is indeed "Shrinking"' as worldwide communication become common place. A notable example is the 'teleport' now used throughout the world (46). It consists of satellites shared by multiple users. The users of the teleport are linked to the satellite through cable, optical fibers, or microwave links. The idea is to share the high capacity satellite channels in order to reduce users overall communication costs. The teleport transmits all types of images such as, voice, data, facsimile, video, etc. with a wide diversity of data rates.

4.4.5.4 Satellite Versus Fibers

A comparison between satellite communication and terrestrial communication is instructive. The introduction of competition in 1984 in United States and somewhat later in Europe changed all that radically. Telephone companies began replacing their long haul networks with fiber and introduced high-bandwidth services. All of a sudden, terrestrial fiber connections looked like the long-term winner. But communication satellite has some major advantages that fiber has not. Many people nowadays want to communicate, while jogging, driving, sailing and flying. Terrestrial fiber optic links are of no use to them but satellite links potentially are (47). A message sent by satellite can be received by thousand of ground stations at once. It is much cheaper than simulating broadcasting on the ground. Moreover launching one satellite was much easier than stringing thousands of underground as well as under sea cables. In short, it looks like the mainstream communication of the future will be terrestrial fiber optics combined with cellular radio.

4.4.6 COMPUTER COMMUNICATION (COMPUCATION) TECHNOLOGY

Computing and communication are natural allies. Both concern information when computing, we manipulate and transform information; we transport information. Though this distinction seems logical enough, computing and communication are so intertwined that it is difficult to determine where one stops and the other begins. “Shannon recognized that information was a common element. Indeed the utility of both communication and computing resides in the information they supply to users” (48). The convergence of computers and communications resulted in the emergence of new technology which has been called “Computer Communication Technology” (49). It is a descriptive term and there is no doubt that this new technology is going to have an increasing important role throughout the communities in the office, factory and Library. Communication technologies will alter, regulate and control many of social interactions.

4.4.6.1 COMPUTER

Computer is a mechanical and electronic contrivance and is capable of carrying out mathematical functions at high speed and accuracy. It is capable of storing and processing huge quantity of information and performing calculations through the data processing machine. Computation, information storage, communication and control are the major functions of most computers (50). Super computers are endowed with artificial intelligence and they are capable of intermediate level reasoning as well huge amounts of information can be systematically stored in its memory for subsequent retrieval and use. A computer memory may be of Read Only Memory (ROM) or Random Access Memory (RAM) variety.

4.4.6.2 Human Machine Communication Process

Human thinking of ideas and artificial intelligence is the relation of human – machine communication process (51). A computer uses many devices to communicate with human beings. The followings are the various system components in a computer toward electronic message transmission.

i) Input: Devices, media and techniques used in the process of human machine communication such as keyboard, the mouse, input pen, touch screen microphone, etc.

ii) Processor: A systematic series of operations to achieve the desired result. Processor is the main component and is the heart of the computer system.

iii) Output: Devices or processes involved in the transfer of information out or information transferred from the internal storage of a computer to any device outside the computer like display screens, printers, graphics plotter, visual display of online work station, etc.

4.4.6.2.1 Computer Communication Language

Language is a set of rules adopted to convey information. A language used to express programme is termed programming language. It is a system of communication, which includes all the symbols, characters and rules to be followed while communicating with the computer. A computer has a machine language, which is used directly by a computer. It consists of strings of binary numbers by which the processor can directly understand. Assembly language translates the specified operation code symbol into its machine language. High level language is a computer programming language, which is nearer to the natural language.

4.4.6.3 NETWORKS

Networks allow many users to share a common pathway and communicate with each other. The subject of networks is complicated, yet the use of networks is growing at a fast rate. According to William L. Schweber, network is "a communications system that supports many users" (52).

The term 'network' means many different things in various applications, and there is no single most correct definition. By describing where networks use and under what conditions, however, the general meaning of the word as used in communication will be made clear. A network serves many users, but not necessarily at the same time. The telephone system is the largest network in existence. Networks can be generally grouped into open networks and closed

networks (54). An open network is public and is available to virtually anyone. The telephone system is a good example of this type. In a closed network, only users who have a direct, close relationship to the application have connections.

4.4.6.3.1 Network Topology

"Topology" is a mathematical term, which refers to the way the interconnection paths between the many users, or nodes are arranged. There are many way to run channels that allow data to go from one user node to another user node. The simplest way is to have a path from each user of the network to every other. Star topology, Bus topology, Ring topology, etc. are the important types of topologies used in different network systems.

4.4.6.3.2 Computer Communication Networks

The interweaving of computing and communication had led to information networks of great complexity and utility. Transmission lines can be used to connect a computer to another computer or a computer terminal to a computer. Networks have following prominent features such as:

(i) Multiple connection: Connecting a computer or terminal to any of a number of other computers at various locations.

(ii) Sharing: Permitting several terminals or computers to use the same transmission line alternatively.

(iii) Multiplexing: Permitting several terminals or computers to translate data over the same transmission line simultaneously.

(iv) Message Packing: Interleaving data into the line so that idle periods of one transmitter can be used to send data from another.

4.4.6.3.3 Hardware requirements

Equipment that makes of the hardware of computer communication systems, are bridge, gateway, network interface card, terminals, modems or acoustic couplers, and hubs.

Bridge: Consists of a computer with two or more network interface cards connecting two different types of networks. For example, one interface card might

connect to an Ethernet System, while a second card connects to a Token Ring System. These two systems speak two entirely different data languages that is recognized by the other.

Gateway: Is used when simply transferring data between networks is not enough. Some network systems (in particular mainframe or minicomputers- based systems) require specific instructions on how data is to be managed once it is received onto the network. A gateway is also required when connecting two or more networks that are running on top of different Operating System (OS).

Network Interface Card: It is the key component of the network workstation. Its chief purpose is to send data out onto the network and receive data sent to the workstation in which it resides. Each network card is manufactured with a unique, permanent electronics address. The licensing system allows the manufacturer to encode a unique address on the card. This licensing system ensures that no address is ever duplicated.

Terminals: A device that allows users to transmit data to, and receive data from computer or other information- processing machines. Terminals designed for interactive applications can be categorized in a number of ways. With respect to their electronic circuity, terminals can be categorized as dumb, smart, or intelligent.

Modem: is an interface unit that enables a computer or a terminal to transmit and receives data using ordinary telephone lines. It stands for modulator demodulator (56). Two modems, one for each computer, are needed to computer communication over telephone lines. Modem changes computer or terminal generated *digital signals* to *analog signals*, so that the data can be transmitted over voice based telephone line. Electric signals generated by a terminal are modulated to make sounds similarly to those we hear on a voice telephone. After reaching its destination, the analog signal is demodulated by another modem to computer understandable digital signals. Modems are necessary only when an analog communication channel that is normal telephone lines are used. For transmission media than telephone lines, the modem is not required. There are two types of modems such as direct-connected modems and acoustic couplers. A direct connected modem is a hard-wired device that plugs directly into a modular

telephone jack. Acoustic coupler modem uses a pair of rubber cups that fit over a traditional telephone handset to send and receive signals through mouth-piece and ear-piece. It changes digital signals into sounds that are emitted into a telephone receiver, cradled in rubber cups.

Hubs: Are used to interconnect the terminals and servers. All the networks (Except those using coaxial cable) requires a central location to bring media segments together. These central locations are called hubs. A hub organizes the cable and relays signals to the media segments.

4.4.6.3.4 Communication Software

The usage of computers will certainly improve the productivity and efficiency of many in house library routines, microcomputers are increasingly being used to communicate with other computers. Terminal emulation online with a microcomputer makes it possible to access online services, e-mail or bulletin boards, to transfer files to and from another computer, or to act as a terminal to an in-house mini or mainframe computer.

4.4.6.3.4.1 Features of Communication Software

There are various communication software. Software for communications should be able to do the following:

i) Deal with the idiosyncrasies of different telecommunications networks and different hosts when transferring data. The telecommunication line variables such as baud rate, parity and duplex, etc. are stored within the program for each host to be accessed.

ii) Store within the program the log on procedures required for the remote computer. Most packages now allow completely automatic logon. Some provides additional programmable function keys or 'user-defined' keys, which are useful for storing frequently, used commands, search sequences or log off commands.

iii) Allow the option to transmit a prestored search strategy either in block or line by line, thereby enabling the user to adjust the strategy if necessary.

Some communication software packages offer additional features. The facility to radial or cycle telephone numbers is useful to save time, should the

preferred route fail, if more than one telecommunications route is available for a particular service. Several packages have an editor within the package so those files can be prepared without the need for separate text editor word processing software. In case of on-line facilities, a number of Packages now store incoming data automatically. This gives the user a chance to redisplay previous screens of a search and take a screen dump if necessary.

4.4.6.4 DIFFERENT TYPES OF COMPUTER NETWORKS

Computer networks are described and categorized many ways. One way of describing is the way computers or nodes are connected, (centralized and non-centralized networks). Another method is in terms of the physical or geographical location of the Nodes, (LAN's and WAN's). Networks may use circuit or message switching or both. The modem telephone network is of this kind and has been used extensively for data transmission. The network contains many switching nodes. A local switching node can connect local terminals to a local computer, thus there need not be as many computer ports as terminals. For longer distances, connections (called trunks) between switching centers can be used. Trunks may be used by many different terminals on different occasions. Transmission facilities between centers may be multiplexed, so that they can carry many simultaneous communications. One of the important methods of describing networks is in terms of the physical or geographical location of the nodes. The two basic types of such networks are known as Local Area Networks (LANs) and Wide Area Networks (WANs).

(i) Local Area Networks: A local area network is private communications network connecting two more computers directly by a cable within a limited local area, such as room, a building or a cluster of buildings LANs vary in the types and numbers of computers that can be connected, the speed at which data can be transferred, and types of software used to control the network (55). The basic benefit of a LAN is that it reduces hardware costs because several computers and uses can share peripheral devices. Users can also share data and software. The LANs have horizontal topologies in the form of star configuration, bus configuration, ring configuration etc.

(ii) Wide Area Networks: A Wide Area Network (WAN) consists of two or more computers that are geographically located in distance places and are linked with by communication channels, such as telephone lines or microwave relays system. They often use vertical topologies, including the hierarchical and mesh topologies.

iii) Metropolitan Area Network (MAN): These Networks are used to interconnect LANs that are spread around a city. MAN is a high speed network that can carry voice data and images at up to 200 Mbps or faster over distance of up to 75km. A MAN can include one or more LAN as well as telecommunication equipment such as microwave or satellite relay station. It is smaller than WAN (56).

iv) Intranet: Intranet can be designed as a network connecting an affiliated set of clients using standard Internet protocols, especially TCP/IP and HTTP. Another definition of an Intranet would be that an IP-based network of notes behind a firewall, or behind several firewalls connected by secure, possibly virtual, networks (58).

v) Extranet: Extranet is an acronym for "extended intranet". An extranet is a network that links business partners to each other over the internet by providing access to certain area of one another corporate intranets. (59). It can be defined as a business to business intranet that allows limited, controlled, secure access between a company's intranet and designated, authenticated users from remote locations or in other word's an intranet that allows controlled access by authenticated parties.

4.4.6.5 THE INTERNET

Internet is truncated version of internetworking, which refers to interconnecting two or more computer networks. A computer network is interconnection of autonomous computing systems through communicating systems through a communication media. The major goals of networking are to felicitate resource sharing and communication among users connected to hosts. Internet, being network of networks, has the same major goals and spans across the entire globe, compared to limited geophysical area covered by local area and wide area networks. Consequently, the Internet can be thought of as vast pool of computers, people and information spread across the entire world.

4.4.6.5.1 History of the Internet

Although the history of the Internet is well explained by associations, organizations and individuals, however the researcher felt to give the boosters as it is very closely related to the present study.

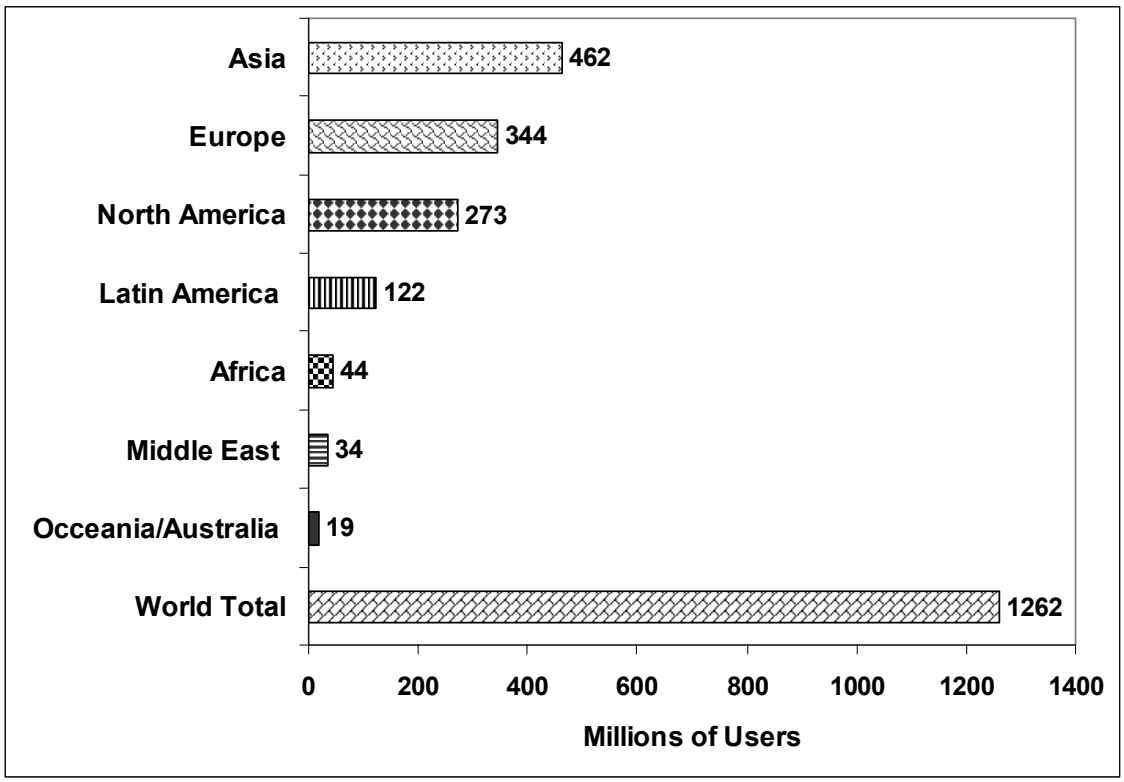
The original concept for the Internet began at *"The Red Corporation"* in the early 1960s. Following the Cuban Missile Crisis, several researchers began discussing the idea of a decentralized network spanning the United States. In the late 1960s during the Cold War, and the U S Department of Defense was particularly concerned with the possibility by the Advance Research Project Agency. It was researched and defense network created by the US Department of Defense in the early 1970s allowed scientists and researchers better communication and data exchange. The **ARPANET** (Advanced Research Project Agency) was especially important to the Internet project, and was often called the backbone network because it was the central WAN that tied researchers together. Each researcher working on the Internet project had a computer connected to the ARPANET. In 1972, the number of centres connected to ARPANET was 23 and increased to 40 in 1974.

The technological evolution added strength to the Internet and that transformed ARPANET into Internet of today which included: the openness of the UNIX operating system, the distribution of "Unix-to-Unix Copy Programme" (UUCP) for electronic mail transfer services among computers, the creation of USENET news relay system by students. The distribution of software tools by University of California at Berkeley called BSD (Berkeley Software Distribution) and the invention of Ethernet. All these jargons may sound strange to non-technical users, but all of this meant that public-domain distribution and source code licensing to academic institutions happened to be the key success factor in the phenomenal growth of the Internet. One of the early outcomes of this initiative was the development of new ways of routing data in multiple paths using unit of data (packets).The standard for communicating on the Internet today known as **TCP/IP** is the abbreviated form for Transmission Control Protocol/Internet Protocol. The key concept in TCP/IP is that every computer has to know or be able to figure out where the other computers are on the network, and can send data by the quickest

route, even if part of the route is down. If it finds that none of the computers are responding being very busy, or does not receive the message, then it can be checked on proposed network map through network topology. Hence, it searches some other computer for communication of message. Thus computer, using TCP/IP can link with Internet. Around 1980, two unaffiliated networks started up. Usenet and BITNET were grass-roots networks based on the concepts of free access to information and ease to grew, users wanted to share information across networks. Thus, connections were built between the networks so that mail and news could be connected. Other new commercial networks such as CompuServe and American Online (AOL) also drew large constituencies, and many people found themselves on more than one network. National Science Foundation Network (NSFNET), known as the backbone by ANS (Advanced Network & Services) a research oriented non-profit company set up by Merit Network, IBM and MCI in 1990 under a cooperative agreement between NSF and Merit. After 1995 this contract ended, the running and maintaining of NSFNET has been taken over by the Internet services providers like America On-line MCP and sprint in the United States. On an overall basis II of Internet Engineering Task Forces represented by the government and academic organizations largely governs the Internet.

From a few connected institutions, word spreads about the value and ease of collaborative work and, over time, and more people connected their research institutions to each other. They also began to connect the manufacturers of equipment, computers and software which are used to support the scientific and research mission. For over twenty years, this network served the research community well, and it grew each year as more people move out from the larger, earlier-connected institutions to small institutions (60). However, the number of the Internet users has increased a thousands fold and thousands of new users are being added daily. More than one million people are using the Internet daily, since its creation in 1983; the Internet has grown exponentially in terms of number of networks connected to it. In 1985, the number was approximately one hundred. By 1987, the number has grown to two hundred, in 1989, it exceeded five hundred and in 1990 it was 2,218. In May 1994, the Internet Society on International

Organization (ISIO), set up to encourage the network, estimated that there were more than thirty thousand networks of computers, making up the Internet. Some of these networks in turn connect thousands of computers, spotted around the world. From the beginning in 1993, each year, more and more countries join the Internet in order to share its resources (62). The world region Internet usage has been given in the **Figure 4.1**.



Source: http://www.internetworldstats.com/stats.htm

Figure 4.1: World Internet Users by Regions- Nov 2007

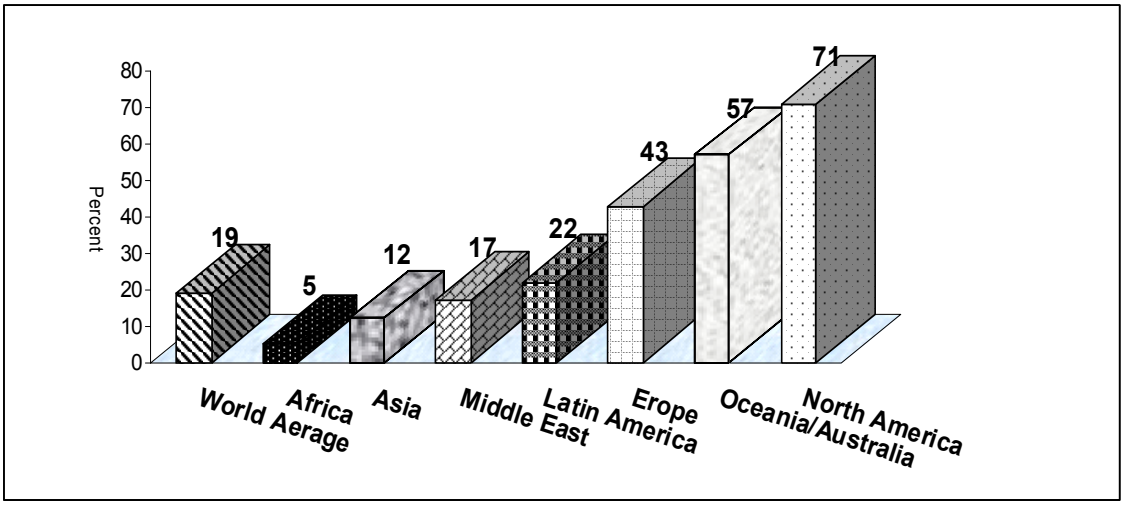
Figure-4.1 indicates Internet usage in different regions of the world. It shows that maximum Number of the Internet users (462 millions) are in Asia, followed by 344 millions Europe, 273 millions North America, 122 millions Latin America, 44 millions Africa, 34 millions Middle East and 19 millions (minimum) Australia/Oceania. It represents that the Internet users in Asia are more than other Regions of the world. The details of the world Internet users and population statistics have been summarized in Table 4.3.

Table 4.3: World Internet Usage and population Statistics

World Regions	Population (2007 Est.)	% Population of World	Internet Use, Latest Data	% Population (Penetration)	% Use of World	Use Growth 2000-2007
Africa	941,249,130	14.2 %	44,234,240	4.7 %	3.5 %	879.8 %
Asia	3,733,783,474	56.5 %	461,703,143	12.4 %	36.6 %	303.9 %
Europe	801,821,187	12.1 %	343,787,434	42.9 %	27.2%	227.1 %
Middle East	192,755,045	2.7 %	33,510,500	17.4 %	2.7 %	920.2 %
North America	334,659,631	5.1 %	237,168,545	70.9 %	18.8%	119.4 %
Latin America/Caribbean	569,133,474	8.6 %	122,384,914	21.5 %	9.7 %	577.3 %
Oceania / Australia	33,568,225	0.5 %	19,243,921	57.3 %	1.5 %	152.6 %
WORLD TOTAL	6,606,970,166	100.0 %	1,262,032,697	19.1 %	100. %	249.6 %

Source: www.internetworldstats.com/stats.htm

Table 4.3 indicates that maximum usage of the Internet in the world (36.6%) belongs to Asia, followed by 27.4% Europe, 18.8% North America, 9.7% Latin America, 3.5% Africa, 2.7% Middle East and 1.5% (the minimum) Oceania/Australia. However Figure 4.2 summarizes penetration of the Internet globally.



Source: www.internetworldstats.com/stats.htm

Figure 4.2: The Internet Penetration by world Regions

Figure 4.2 shows that maximum Internet penetration is in North America (71%) followed by 57% in Oceania/Australia, 43% in Europe, 22% in Latin America, 17% in Middle East 12% in Asia, 5% (the minimum) in Africa. It can be summarized that the use of the Internet has increased tremendously. Some of the studies have also shown that the Internet is playing vital role in teaching, training, and research activities. Some of the LISc professionals have already put their syllabus, reading full text material on the Internet. The open archiving/ access on the Internet put an addition step in this direction.

4.4.6.5.2 Technical Aspects

Large number of computers are connected through communication media, such as telephone lines, Leased lines, Satellites, etc. and communication hardware/software such as Routes and gateways. Routers and gateways are switches that will move data from one host to another host through the media. These provide fast bit carrying capacity to Internet (61). The Internet interconnects heterogeneous networks that are networks comprising of variety of hardware platforms, operating systems, information storage, etc. The management of such heterogeneous networks and information exchange is achieved by adoption of the following methodology.

(i) Client Server Architecture: The computer, which needs to access information, is called client, and the computer, which provides resource, is called server. The basic activity involves client getting connected to server, accessing the required resource and closing connection. All application involves this basic resource access mechanism.

(ii) TCP/IP Protocol: Protocol is a set of well defined, rules to be followed by communication partners for reliable and meaningful exchange of information. Transmission control protocol takes care of transporting the packet from client to server and Internet protocol takes care of moving the packet across networks.

(iii) Application Level Protocol: TCP/IP protocol carries the packets from client to server and vice-versa, without bothering to interpret what the packet contains. It is the job of application protocol to interpret and provide the intended services to the end users such as e-mail, Remote Login, File Transfer, etc. may be noted that Programs at respective peer level, communicate with each other on client and server machines.

4.4.6.5.3 Services of the Internet

In January 1992, the *Internet Society* (ISOC) was set up to promote the use of Internet and perhaps eventually take over managing it (62). The Internet has the following main applications:

4.4.6.5.3.1 E-mail

Electronic mail, popularly known, as E-mail is a facility through which messages can be exchanged electronically over the Internet. The ability to compose, send and receive electronic mail has been around since the early days of the ARPANET, and is enormously popular. It has message delivery speed as high as that of telephonic accessing. Unlike telephone messaging, e-mail does not require that both parties be available at the same instant. It also leaves a written copy of the message. It has additional features such as replay to message, broadcast, carbon copy, and blind copy, to increase the effectiveness of the

message exchange. To avail the services of e-mail, user should have address of the sender and program to handle mail application. SMTP (Simple Mail Transfer Protocol) is one of the protocols used for mail. Transmission of e-mail requires a telecommunication network. The vast majority of e-mail is transmitted as computer– compatible data and travels along data networks. Common forms of e-mail system include telex, facsimile, communicating text processors, message switched networks and computer based message system.

The complete range of e-mail is applicable to office and business environment. Further, it is also useful in various aspects of library environment. There are three main applications, where the impact of e-mail is likely to be felt.

(i) As an alternative mail service.

(ii) As a complement to the telephone service.

(iii) As an optional medium for holding meetings and conferences.

Thus, it may be stated that e-mail may play a significant role in information dissemination services.

4.4.6.5.3.1.1 Application of E-Mail for Library and Information Services

In addition to general applications of e mail, there are special uses for LIsc. E-Mail has all the potentialities of using if for some of the library and information services, and has already become an integral part of the libraries in the developing contries. Some of the major areas, where the e-mail could be used as effective media are follows:

(i) Document ordering and claiming: E-mails are being used by the libraries for ordering the books, journals and other reading materials. It is possible to check the availability of certain titles with publishers by sending a list through this system and on confirmation final orders can be placed periodical claiming is another area where e-mail could be used more effectively and efficiently. It would be much faster and unnecessary delays could be avoided.

(ii) Professional communication: E-mail facilitates communication among the LISc Societies. It can also become a convenient means for professional membership to announce meetings and provide professional information to its constituencies. E-mail also permits individuals having common interest, to

communicate without geographic restriction. Libraries can collaborate on various projects including bibliography compilation, collection development and policy making using e-mail. These applications will have great impact on inter-library co-operation and networking.

(iii) Inter Library Loan: Inter Library Loan is one of the major activities of the ICLs. E-mail provides better and faster means of communication. Through this system, library can forward its request for a document to one or more libraries at any time. It is even possible to check the availability of the documents before confirming the actual document request and receive the response. This saves a lot of time both for users and the staff.

(iv) Document Delivery: Is another application of e-mail in libraries. Now always, many requests for documents are generated out of on-line searches and some of the online database owners are offering the capability as a part of their search protocols. Another aspect of electronic document delivery involves the advent of complete text database, especially for complete text of journal databases. These are another aspect, where e-mail could be effectively used, that is databases can be searched and results can be downloaded and sent to the user mail boxes.

(v) Reference Service: E-mail is more effective means in transmitting of reference and answers. It can be from librarian to librarian, patron to librarian and librarian to subject specialists, etc. One need not visit the libraries to get the information on certain topics. If the answers are brief, it could be easily transmitted, instead of writing a separate letter. E-mail can also be used by the librarian on the campus and outside, to send the reminder notices, recent additions lists, etc. to the users. Day-to-day correspondence could also be sent through e-mail. Users can give their feedback about the services through this media (63).

4.4.6.5.3.2 File Transfer

The Internet is a collection of large amount of programmes, text, data files, which can be received; majority of it is available free. Protocol used for this is called File Transfer Protocol (FTP). It is possible to copy files from one machine on the Internet to another. Vast numbers of articles, databases and other information are available this way.

4.4.6.5.3.3 News

Newspapers are specialized forums in which users with a common interest can exchange messages. Thousands of Newsgroups exist, on technical and non-technical topics, including computers, science, recreation and politics.

4.4.6.5.3.4 Remote Login (Telnet)

This service lets the user to login to a remote host telnet. Telnet is an Internet Protocol that enables user to log onto a remote computer on the Internet and use the remote computer as if were a direct, local connection. By using telnet, users anywhere on the Internet can log into any other computer on which they have an account (64).

4.4.6.5.4 World Wide Web

The World Wide Web (WWW) is a client server based, distributed hypertext, and multimedia information system on the Internet. The concept of the web was born in European Particle Physics Libratory, where the web server software along with a character-based client was developed and made available on the Internet (65). WWW today has become the most popular information service and is associated with accessing and browsing information resources on the Internet. Web uses a protocol called Hypertext Transfer Protocol (HTTP). The web servers maintain information in the "web pages", which are simple ASCII files with all the text marked with Hypertext Mark-up Language (HTML) tags. It has tags for providing references to other web pages, which can be on the same server or any other server on the Internet irrespective of the geographical location. This facilitates hypertext links across the documents on the Internet.

The clients or browsers access the web pages on the server's renders and formats them according to the HTML tags to display on the client's system. When the user selects a hypertext link on a web-page, client can follow the link and fetch the referred document irrespective of the location of the document on the Internet. The Uniform Resource Locator (URL) specifies the location of the documents or web pages. It is a simple way of describing almost any information resource, using

a standard format for locating information on the Internet, as: <Protocol>://<Host.domain>:<port>/<protocol-specific>

For instance: http://www.indiapost.gov.in/Index.html

Specifies a web page with the file name index.html on the Internet site named www.indiapost.gov.in

4.4.6.6 MULTIMEDIA

Multimedia is a combination of some or all forms such as text, data images, photographs, animation, audio and video, which are converted from different formats into a uniformat digital media and is delivered by computers (66). Unlike the analogue media, the digital media, which allow users to manipulate according to the needs, use at their pace, and interact at any point of the program when a multimedia program is developed in a hypertext environment, the resulting product is called 'hypermedia', so multimedia would then be a part of the hypermedia products but not vice-versa. The basic difference between these two is in the organization and linkage of the information fragments. The information fragments in multimedia are organized linearly whereas in hypermedia, these are non-linearly organized with links to each other. The main elements of the multimedia are:

(i) **Text**: Information about an object or event, etc. notes, captions, subtitles, contents, indexes, dictionaries and help facilities.

(ii) **Data**: Tables, charts, graphs, spreadsheets, statistics and row data.

(iii) **Graphics**: Both traditional and computer generated such as drawings, points, maps, etc.

(iv) **Photographic Images**: Negatives, slides, prints, video cameras, etc.

(v) **Animation**: Including both computers generated video, etc.

(vi) **Audio**: Includes speech and music digitized form cassettes, tapes, CD's, etc.

(vii) **Video**: Either converted from analogue film of entirely created within a computer.

4.4.7 CD AND DVD TECHNOLOGY (OPTICAL DISCS)

The combination of computers and lasers has led to a compaction of information into miniature lives. This has optical computing holography, neural

networking, optical interconnection, laser printers, laser scanners and optical storage (67). An optical disk is a thin, circular disk which can store information and data is written and read through the use of laser beam. Data is stored as either a zero or one in binary code. It is usually 4.75 inches in diameter and less than 1/20 of an inch thick. It can store enormous amount of data on a small sized single disk. All optical disks are round platters. The most commonly optical disks are CDs and DVDs. Both the technologies are used extensively for various ICL services and applications.

4.4.7.1 Compact Disc

CDs and DVDs are very common nowadays and are being used in its various forms and formats. Compact disc is a rigid plastic platter disk (12 centimeters-4.75 inches), which used to store digital data. It is used to store audio and video signals in digital form and also computer data. Compact Disks are Optical Disks. The various compact disk formats are typically categorized by the type of data they contain. The best-known formats are intended for music and/or video recording. They include compact Disc digital Audi (CD-DA), Compact Disc-Video (CD-V), and Compact Disk-Interactive (CD-I). Digital Video Disks (DVDs). They will be useful in CD-publishing, online storage of text, audio and video and archival back ups and are being used by ICL and LISc professionals extensively.

4.4.7.2 CD ROM

CD-ROM is an acronym that stands for Compact Disc Read Only Memory. It is an optical disc of 120mm diameter and a hole of 15cm of center, with thickness 1.2mm. Data is recorded in digital from using laser beam. User can only read the disc, but cannot write on it, nor can erase anything written on it. It is in a computer readable form. The disc is recorded on one side only. Each disc can store approximately 600 MB of information, equivalent to 300/000 A-4 size pages.

4.4.7.3 DVD

DVD (Digital Versatile Disk, formerly Digital Video Disk) has the same 12 cm size as a CD but is called “versatile” because it appears destined to replace not

only the laser disk and the audio CD for entertainment but also the CD- ROM for use as auxiliary computer memory. DVD technology uses a higher frequency and shorter wavelength laser to each pit, to make a CD. So, the surface of DVD contains microscopic pits, which represent 0s and 1s of digital code which can be read by a laser. Further more, the DVD's spiral tracks are denser than those of a CD. Although the diameter and total thickness of CD and DVD are same, yet capacity of DVD is 4.7 GB each side. DVD-ROM, that is, its prerecorded pit-encoded information can be read but not rewritten. It is used for mass distribution of pre-recorded software programs and multimedia. There also exists rewritable version of DVD-R known as DVD-RW. The differences between CD and DVD are listed in the Table 4.4 (68).

Table- 4.4: Characteristics of CD and DVD

Characteristics	DVD (Digital Versatile/Video Disc)	CD (Compact Disc)
Size	12 cm (4 ⅓)	12 cm
Versatility	Very versatile because destined to replace laser disc, audio CD for entertainment and CD-ROM.	Not very versatile as DVD.
Technology used to etch pits.	DVD technology uses a higher frequency (shorter wavelength) laser to etch pits.	CD uses lower frequency laser than DVD to each pits.
Spiral Tracks	DVDs Spiral tracks are more dense than CD circumferentially -0.4µm, and radially-.74µm.	Spiral tracks are less dense circumferentially -0.83µm radially-1.6µm.
Capacity	8.5 GB (single side) 17 GB (when recorded on both side)	650 MB
Error correcting code	Read-Solomon Product Code (RS-PC). It is ten times robust than the code used on CD	CD uses Cross Interleaved Read-Solomon Code
8 to 14 modulation for recording	EFM plus 8 bit to 16 bit modulation	EFM 8 bit to 14 bit modulation used

Source: Taxman's Information Technology by Sushila Madan

4.4. 8REPROGRAPHY, MICROGRAPHIC AND PRINTING TECHNOLOGY

Theses technologies are still widely used technology in libraries globally. The technology of reprography makes a big impact on the document delivery systems. Most of the research libraries have reprographic machine and provide photocopies of any document on demand. Ever since John Benjamin dancer, the father of microphotography produced it as early as 1939. There have been predictions that microforms will have a great impact on libraries and the world of books will be replaced by the world of microforms. By using micrographic and reprographic techniques, we can condense the bulky archives and newspapers and solve the storage problem. They help in resource sharing and save users time. Library is a store home of knowledge and it store, process and communicate the information in different forms and formats.

4.5 IMPACT OF INFORMATION TECHNOLOGY ON ICL

The impact of new technologies is seen in almost every human activity. The size and the rate of growth and change in the pattern of collection, storage and transmission of information are some of the major limitations in any library. The basic concept in the use of new technology is to free the information scientist from the routine jobs connected with library operations, which can be entrusted to computer. In this age of science, electronic computers provide information, which help to reduce the bulk of the printed materials. The computers also help to make the libraries and society paperless in future.

Lancaster predicted that we will soon be entering the era of paperless society; an era in which print on paper will be replaced by electronics. Thus "library" will not be contained any printed material at all. It may become a room containing computer terminal only. But this prediction seems to have overlooked the fact that libraries are repositories of the recorded knowledge is a mosaic that will make libraries more complex. In addition to look stacks and reading tables, there will be carrels and computer terminals'' (69). The emerging communications technologies especially the interactive digital devices will drive the information future. The technology can handle the data overload but a human being cannot. It

is the use of information technology that will give librarians as audience, an attitude, an amplification of self that will raise their status in life. The detailed impacts of IT devices have been summarized in Table 4.5.

Table-4.5: Impact of IT Devices on the Operations of LISc

Operations	IT Devices/Systems
1. Collection (Capture)	Remote resource sensing satellite, radar systems, electronic cameras, VCR systems, videodisks.
2. Transportation	Coaxial cables, optical fiber cables, microwave links, communication satellite, cellular mobiles radio, laser beams, facsimile transceivers, videophone, telephone, electronic teleprinters, modems , multiplexers
3. Storage	Memory chips, magnetic film/tape/drum holography, laser emulsion, microfilm.
4. Processing	Integrated circuits, computer software, peripheral equipments.
5. Retrieval	High definition television, teletext, videotext, pay television system, on-line databases/databanks.

Source: Communication media and electric revolution by Aruna Zachariah

The convergence of electronics, computers and communication formed the basis for an advanced Information Technology, that has a direct impact on information society, can be summed up as follow:

(a) Increased computer power leading to faster and cheaper computer processing which facilitated automation of even low budget libraries.

(b) Improved telecommunications, such as ISDN (Integrated Service Digital Network) with greatly increased capacity of data transmission, which facilitated introduced of new services such as e-mail, fax, teleconferencing, etc.

(c) Cheaper data storage, such as optical storage media that increased the storage capacity of the libraries.

(d) Digitization of information-text, graphics, photographic speech; sound, etc. that provides quick transmission of any type of data.

(e) Better data transfer between different system and media, such as co-axial cables, optical fiber cables, satellite communications, etc. has promoted the resource sharing among the libraries.

(f) Increased reliability of hardware and software, which has increased the performance efficiency.

(g) User friendly systems that are developed to enhance the interface between technology and users of the library (70). Consequent to the developments on IT, the libraries are being provided with the means by which they can improve their services. The integrated library management is possible today with the application of Information Technology.

The overall impact of IT on library and information science is broadly subdivided into three major divisions as follow: Impact on the technical services, Impact of public services and Impact on library organization structure.

4.5.1 IMPACT OF IT ON TECHNICAL SERVICES

The Technological developments, which seem to have had the widest impact to date on technical services in libraries, are the growth and developments of bibliographic utilities and the more recent development of integrated automated local systems. Bibliographic utilities have prospered in large part because of the role they play in cataloguing. Automation, in the form of bibliographic utilities and MARC format, has revolutionized the practice of cataloguing. Today's librarians rely on MARC format to provide proper cataloguing services to their users.

On-line Public Access Catalogue (OPAC) can substantially reduce the cost of maintaining a catalogue. Many paper files can be eliminated and decentralization is possible because, staff can access the on-line files, wherever a terminal is located. If the OPAC is integrated with other technical service files in a full function automated system, work throughout the department can be streamlined and reorganized. The impact on staff responsibilities and assignments can be significant.

Serials automation has proceeded more slowly than that of other technical services operations. The undertaking has been difficult, complex and frustrating. But after the quick proliferation of IT, successful implementation of automated serials control, including check-in, claiming, binding control and routing of materials has become more feasible. Collection development may be treated as part of public services or as part of technical services. It may be carried out within the acquisitions department or in a separate unit. Regardless of the organizational arrangements, libraries, who select materials for the collection use a variety of bibliographic tools automation has made available many of these tools in machine readable format and offered new ways of monitoring collection development and management activities. Co-operative collection development and management have become increasingly important in libraries due to tight budgets, rises prices and the information explosion. Bibliographic utilities facilitate these efforts through shared holdings, information and automated interlibrary loan subsystems to speed resource sharing (71).

4.5.2 IMACT OF INFORMATION TECHNOLOGY ON PUBLIC SERVICES

OPAC'S which provided speedy on-line access to all the library's holding by means of a computer terminals, are affecting library operations as powerfully as has the appearance of bibliographic utilities and automated regional networks. OPACs serving either a single institutions are now wide spread and continue to be implemented in libraries across the country. Now optical technologies make possible and affordable the mounting of CD-ROM public catalogues at standalone microcomputer stations an operational reality in virtually any library. Advances in library automation also made possible the rapid development of union lists of serials, arranging holding information for a number of libraries. Library networks made available a central agency that could assemble, merge, and maintain the bibliographic and holding information of other libraries. The development of technology has provided significant improvements in 'resource sharing', especially in interlibrary loan operations.

As in technical services, public services operation have experienced movement of the more routine functions to lower level of staff, as a result of library automation. The verification of bibliographic citations has often become routine and is handled as ready 'reference' searching by support staff. The new emphasis on access to sophisticated information sources has placed new demands on the librarians. Therefore librarian often expected to train and advise patrons in their use (72).

4.5.3 IMPACT OF IT ON LIBRARY ORGANISATIONAL STRUCTURE

A right type of planning is vital for the efficient working of a library. Planning of a library organizational structure requires a through understanding of need of the users, objectives and functions of a library or information center.

The emergence of information technology provided greater impetus for information transfer at both inter and intra-organizational level. Organization of all types become involved with IT and have implemented, IT based systems.

IT will decrease the human work and alters the existing organization structures (73).

4.6 CONCLUSION

Information Technology has not left any human activity untouched with its influence. The IT tools like computers and communication have added new dimension in information handling in libraries. New technologies supplement the older ones and form together with a complex of technologies, which allows for choosing a certain technology for a certain application from a broad variety of technologies for certain application from a broad variety of technologies. The largest single factor, which has caused changes, if any in the library and information services, is Information Technology. It has made it possible to introduce new services, revolutionize many existing services by providing new media, by increasing speed and efficiency of processing and retrieval, by over coming distance and communication barriers and so on.

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